Missouri Botanical Garden

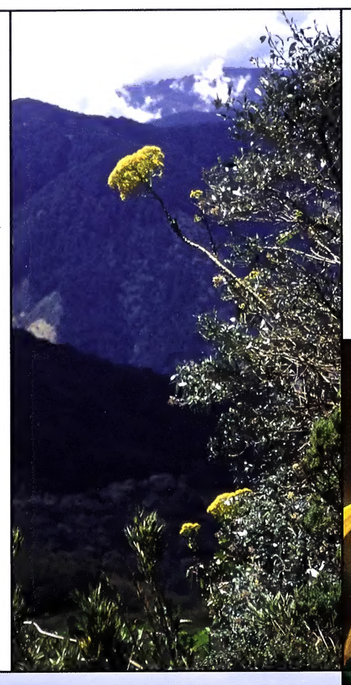
Research: Asteraceae (Compositae)





Species number—Compositae (**Sunflower Family**) contain about 1,535 genera and 25,000 species, 8–10% of the Angiosperms. **The 20 tribes are placed in two subfamilies: Asteroideae and Barnadesioideae.** Related suites of tribes (e.g., those of the non-monophyletic Mutisioideae, Carduoideae, and Cichorioideae) are discernable, however, within the Asteroideae lineage. Ecological success is attributed to strong chemical defenses and pollination efficacy. Compositae are very speciose in temperate regions, where >50% of its species occur.

Missouri Botanical Garden Flora Projects, including ***Flora of North America, Flora Mesoamericana, Flora of the Venezuelan Guayana,*** and ***Flora of China***, treat species of **Senecioneae**, including the cultivated **flame vine** (*Pseudogynoxys chenopodioides*, upper left, **HW**), Mesoamerican *Jessea multivenia* (right, **CG**), and *Tussilago farfara* (lower left, **KN**). In the early 1900s, MBG's **Jesse Greenman** was acknowledged as the world authority on *Senecio*. MBG's **Michele Funston** is the specialist of *Roldana* (Senecioneae).



Reproductive structures—The name Compositae alludes to the composite structure of flowering heads that characterize the family. Florets are clustered on a common receptacle into **capitula**, these subtended by an involucre of **phyllaries**. A few taxa have uniflorous capitula. Capitula are solitary or secondarily arranged into a **capitulescence**. Florets of individual capitula mature indeterminately, whereas capitulescences are determinate. Corollas are **sympetalous**, stamens epipetalous with syngenesious anthers having introrse dehiscence. Ovaries are unilocular, inferior, with one ovule. Fruits are **achenes** (technically **cypselae**) and are topped by a **pappus**. Bisexual florets are protandrous, with **bifid styles** pushing upwards through anther cylinders secondarily presenting pollen via either the pump or brush mechanisms.

The opened capitulum (lower left, **HW**) of *Helianthus annuus* (the **Sunflower**) shows typical **Heliantheae** structure.



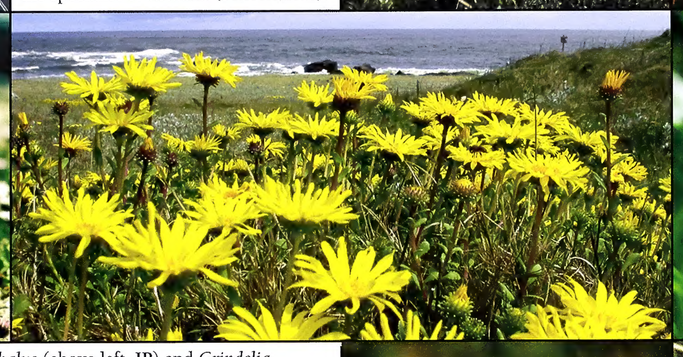




Eupatorieae, including 4-flowered vining *Mikania scandens* (below, **DT**), are characterized by long style branches, yet are **nested within Heliantheae**. *Argyroxiphium* (left) is often placed in **Heliantheae: Madiinae**. Recognition of taxa such as Madieae would preserve Eupatorieae, but segment the Heliantheae. Alternatively, Eupatorieae could be sunk within a broadly defined, monophyletic Heliantheae sensu Cassini. Harvard's **B. L. Robinson** is well known for his work in the early 1900s on Eupatorieae.





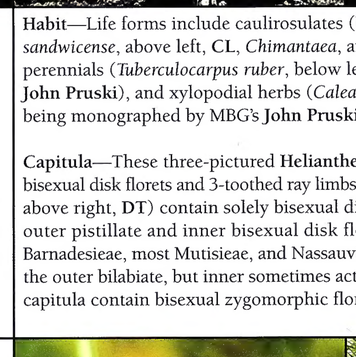


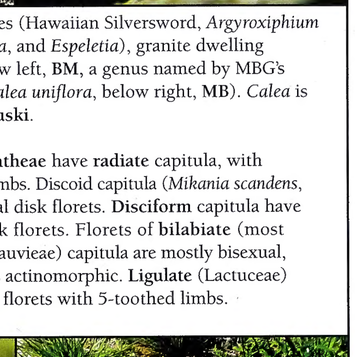


Medicinals and Ornamentals—*Echinacea purpurea* (above, **GY**) is an ornamental used in folk medicine. Pantropical *Sphagneticola trilobata* (n.v. Wedelia, left, **AB**), a Linnaean species reclassified by MBG's John Pruski, is used medicinally and horticulturally. Wedelia is a common ground cover used in many tropical airports, as well as in St. Louis gardens. *Echinacea* and *Sphagneticola* are radiate **Heliantheae**. Many additional Compositae are ornamentals, especially ***Chrysanthemum*** spp. (Anthemideae).

Habit—Life forms include caulirosulates (Hawaiian Silversword, *Argyroxiphium sandwicense*, above left, **CL**, *Chimantaea*, and *Espeletia*), granite dwelling perennials (*Tuberculocarpus ruber*, below left, **BM**, a genus named by MBG's **John Pruski**), and xylopodial herbs (*Calea uniflora*, below right, **MB**). *Calea* is being monographed by MBG's **John Pruski**.

Capitula—These three-pictured **Heliantheae** have **radiate** capitula, with bisexual disk florets and 3-toothed ray limbs. Discoid capitula (*Mikania scandens*, above right, **DT**) contain solely bisexual disk florets. **Disciform** capitula have outer pistillate and inner bisexual disk florets. Florets of **bilabiate** (most Barnadesieae, most Mutisieae, and Nassauvieae) capitula are mostly bisexual, the outer bilabiate, but inner sometimes actinomorphic. **Ligulate** (Lactuceae) capitula contain bisexual zygomorphic florets with 5-toothed limbs.





Astereae, including *Erigeron melanocephalus* (above left, **JP**) and *Grindelia orientalis* (above right, **MB**) are often radiate. MBG's **Julian Steyermark** studied *Grindelia*, and **José Cuatrecasas** specialized in Colombian Astereae. Other Astereae (e.g., horseweed, *Conyza* spp.) have disciform capitula, as does *Pluchea sagittalis* (right, **MB**, Plucheeae). Disciform **Gnaphalieae and Plucheeae** were segregated from **Inuleae**, and Asian *Inula helianthusaquatilis* (below left, **DB**) is clearly radiate.

Pollination—Most Compositae are pollinated by **insects** (see *Inula*, below left). Some tribes (e.g., Cardueae, Mutisieae, Stifftieae) are occasionally **bird-pollinated**. *Gongylolepis jauensis* (Mutisieae) is the sole **bat-pollinated** Compositae. **Wind-pollination** occurs in some species of advanced tribes, including *Ambrosia species* (**ragweed**, Heliantheae), a causal agent of hayfever.

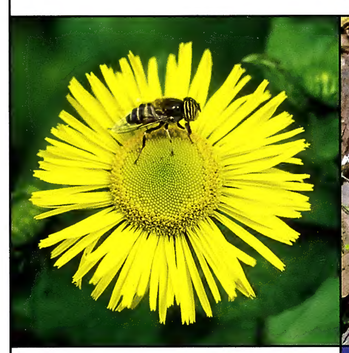




Traditional subfamily classification—In 1819 **Cassini** proposed our tribal classification. **Candolle** recognized three subfamilies for Cassini's tribes: Tubuliflorae (five tribes), Labiatiflorae (Mutisieae and Nassauvieae), and Liguliflorae (Lactuceae). Last century most **synantherologists** recognized only **Tubuliflorae** (then containing tribes of Labiatiflorae) and **Liguliflorae** (containing solely Lactuceae). Lactuceae includes **dandelion** (*Taraxacum officinale*, above left, **KY**) and **chicory** (*Cichorium intybus*, below, **KN**). In 1976, **Sherwin Carlquist** (first author of *Tarweeds & Silverswords*, recently published by MBG Press) placed tribes with **2-banded stigmatic surfaces** on the style branches in **Asteroideae** (Tubuliflorae, this poster's upper photographs) and ligulate, bilabiate, and discoid tribes (with **single continuous stigmatic surfaces**) as **Cichorioideae** (Liguliflorae and Labiatiflorae, this poster's lower photographs), each subfamily being about equal-sized.









Cardueae include thistles (*Cirsium subcoriaceum*, right, **BH**), cultivated Echinops, Asian *Saussurea laniceps* (left, **WL**), and African *Dicoma carbonaria* (below, **GES**). Cardueae have discoid capitula with deeply lobed corollas. Their short rounded style branches with continuous stigmatic surfaces resemble the related Mutisioid tribes, but Cardueae style shafts or style branches are ringed. *Dicoma* is often treated as Mutisieae.





Garden staff and associates—Garden projects, mostly published by **MBG Press**, focus largely on the world's tropical floras, with an emphasis on that in the Americas. MBG's **James Zarucchi** is Editorial Director of the Compositae treatment for *Flora of North America*. **Robert King** (left, **RK**, first author of MBG monographs 22, 54, 55) collects floral buds for chromosome studies, some co-authored with **MBG director Peter Raven**. *Xanthisma gracile* (2n = 2) has the **lowest chromosome** number in the plant kingdom.



The **Guayana Highland** contains many endemic **Stifftieae** and **Mutisieae**. **Endemic Guayanan genera** include *Chimantaea* (*C. mirabilis*, below, **JP**), *Quelchia*, and *Stomatochaeta* (Stifftieae); and *Achnopogon*, *Duidaea*, *Eurydochus*, *Glossarion*, and *Neblinaea* (Mutisieae). *Gongylolepis* (Mutisieae) and *Stenopadus* (Stifftieae) are centered in Guayana, but each has a single Andean species. *Stenopadus andicola* Pruski, a tree to 26 m tall, is **the tallest American Composite.**





Styles and anthers—Tribes are basically recognized by style features. Vernonieae (*Orthopappus angustifolius*, right, **MB & GS**), Lactuceae, and Liabeae, have hairy style shafts. Eupatorieae have appendaged styles. Many Heliantheae have black anthers. The Cardueae and Mutisioid tribes have long anther tails. The long anther tails of Stifftieae are smooth, whereas those of *Gongylolepis* (Mutisieae) are papillose. Other tribes are diagnosed by various combinations of style and anther features.



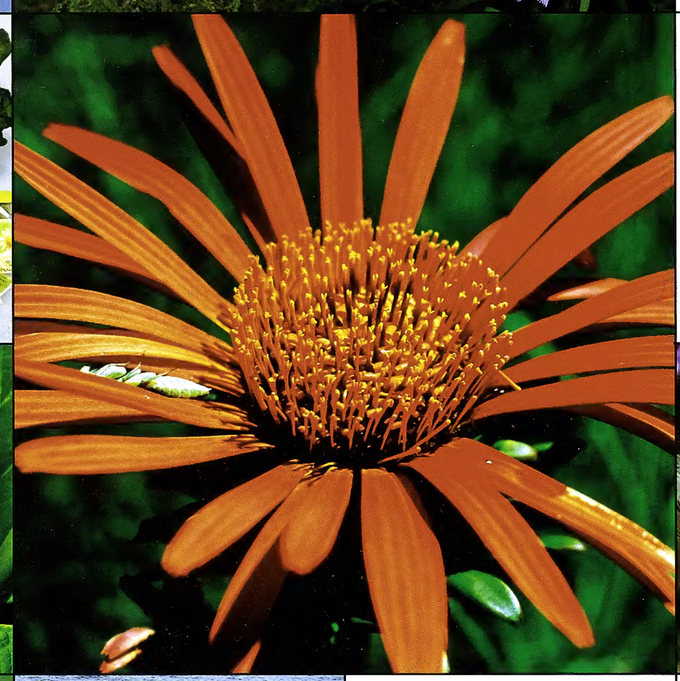




Economic Compositae—For a family of such great size, surprisingly few Compositae are globally important. The photograph at right, however, shows several notable economically important Compositae, including **lettuce** (*Lactuca sativa*), **sunflower** seeds and oil (*Helianthus annuus*), **chicory** (*Cichorium intybus*, added to coffee), **artichoke** (*Cynara cardunculus*), and **chamomile** (*Chamaemelum nobile*).



Distribution—Compositae occur basically everywhere vegetation occurs. The basal tribes Barnadesieae and Stifftieae are restricted to South America, whereas the related, but derived ***Gerbera* (Mutisieae) group** (*Trichocline macrocephala*, above, **GD**) contains members that extend into Africa, temperate Eurasia, and North America. **Astereae, Cardueae, Eupatorieae, Heliantheae, Lactuceae, Senecioneae, and Vernonieae are extremely widespread and speciose**, whereas other tribes (e.g., Arctoteae and Liabeae) are restricted and smaller.



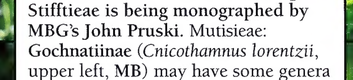
Segregate tribes and genera—The large traditional genera ***Aster, Chrysanthemum, Eupatorium, Senecio,*** and ***Vernonia*** have been variously split into many smaller segregates, with the typical elements generally north temperate.

Nassauvieae, resurrected by MBG's John Pruski, have been treated as Mutisieae: Nassauviinae but differ **from Mutisieae** by long style branches with truncate tips. Nassauvieae are centered in South America, but species of *Acourtia* and *Trixis* occur northwards into the United States.

The Nassauvieae genus ***Perezia*** (*P. pungens*, below right, **CU**) included until recently the segregated North American ***Acourtia*** (*A. microcephala*, below left, **KB**). *Acourtia* differs from *Perezia* by a densely woolly (vs. glabrous) caudex and by fewer, non-strongly radiating corollas.







Stifftieae, a small South American tribe of six genera and 46 species, **was resurrected** by **MBG's John Pruski**. Stifftieae differ from Mutisieae by strictly discoid capitula with dorsally **rugulose style** branches and upper style shafts. Representative taxa seen here are *Chimantaea mirabilis* (upper left, **JP**), widely cultivated *Stifftia chrysantha* (lower left, **AT**), and *Stomatochaeta cymbifolia* (lower right, **JP**). Other genera include *Quelchia*, *Stenopadus*, and *Wunderlichia*, the latter revised by **Graziela Barroso** and **Bassett Maguire**. **Stifftieae is being monographed by MBG's John Pruski**. Mutisieae: **Gochnatiinae** (*Cnicothamnus lorentzii*, upper left, **MB**) may have some genera with similar discoid capitula, but **differ by lacking rugulose styles.**

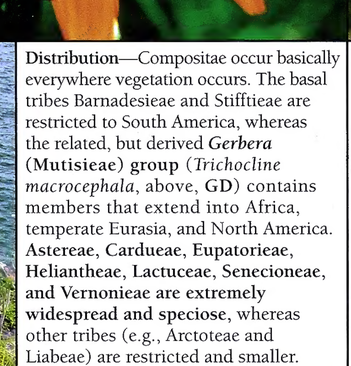
Mutisieae are an original tribe of Cassini, as are Nassauvieae. **George Bentham** reduced Nassauvieae and Stifftieae to Mutisieae. **Angel Cabrera** also recognized Mutisieae: Nassauviinae, and three other Mutisieae subtribes. Cabrera's subtribes are now basically treated as tribes: Barnadesieae, Mutisieae, Nassauvieae, and Stifftieae (part of Cabrera's Gochnatiinae). Barnadesieae and Mutisioid tribes typically have short apically rounded style branches without well-developed collecting hairs and with continuous stigmatic surfaces, but Nassauvieae have longer, truncate style branches.

The showy usually bilabiate capitula in **Mutisieae** are sometimes bird-pollinated, whereas *Gochnatia* is insect-pollinated. Shrubby homogamous, homomorphic, bilabiate genera (*Gongylolepis oblanceolata*, right, **HTB**) are primitive. Vining, heterogamous, heteromorphic bilabiate genera (*Mutisia alata*, left, **HB**) and discoid Mesoamerican *Onoseris onoseroides* are derived.

Recent subfamily classification—The 1980s saw the recognition of **Barnadesioideae**, this based on a chloroplast **DNA** inversion found in all Compositae, except Mutisieae: Barnadesiinae. Thus, most Compositae differ genetically from other land plants and subtribe Barnadesiinae, the latter now Barnadesioideae.

Recognition of only Asteroideae and Barnadesioideae is warranted cladistically, but the use of five subfamilies (sensu **Kare Bremer**, 1996 and **John Pruski & Gisela Sancho**, 2004) is useful, albeit lessening Barnadesioideae's distinctiveness.

Barnadesieae (including *Barnadesia arborea*, left, **MA** and the perhaps basal *Schlechtendalia luzulifolia*, right, **MB**) also have unique floral trichomes, lacking in all other Compositae. The inner lip of the bilabiate corolla is single, as opposed to bifid inner lips of bilabiate corollas in most Mutisieae and Nassauvieae.



Pollen and Chemistry—Basal (Barnadesieae, Cardueae, and the Mutisioid) tribes basically have smooth, prolate pollen. The advanced tribes commonly have spiny, round grains, and also a deletion in the ndhF gene. Basal tribes have a weak protective chemistry, whereas the advanced tribes have an active chemistry, including characteristic sesquiterpene lactones. Species of Anthemideae are the source of Pyrethrin.



MBG's **John Pruski** (author of text) and **Gerrit Davidse** are coordinating the Compositae treatment for ***Flora Mesoamericana.*** Pruski is a specialist in Mutisieae, Nassauvieae, Stifftieae, and *Calea* (Heliantheae). Pruski's association with MBG began in 1979, when he and MBG's Julian Steyermark collected in the Venezuelan Guayana. Formerly, Pruski worked at the New York Botanical Garden (1982–1992) and the Smithsonian Institution (1992–2001). At left (**DC**), Pruski in Amazonian Brazil is holding *Tilesia baccata* (L.) Pruski.

Research at the Missouri Botanical Garden

With operations in over 35 countries around the globe, the Missouri Botanical Garden collaborates with local institutions everywhere MBG botanists conduct research and field work, providing technical expertise, assistance with fund raising, and better communication with the worldwide scientific community.

The research division consists of 37 Ph.D. botanists assisted by 100 support staff and 33 graduate students. Studies concentrate on the plants of Meso- and South America, Subsaharan Africa, Madagascar, China, Vietnam, and North America. Individual MBG scientists are specialists in the plants of particular regions, in the systematics and evaluation of major plant families, and in the interactions between plants and people.

The Garden serves as the headquarters from the Center for Plant Conservation and for several major collaborative publications, such as *Flora of China* and *Flora Mesoamericana*. Visit our website: www.mobot.org.

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Research Text: John Pruski
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AB	Allen Boatman, sent by Bruce Hansen, FLAS	BM	Bruno Manara, VEN
MB	Mauricio Bonifacino, MVFA	KN	Kevin Nixon, BH
DB	David Boufford, GH	JP	John Pruski, MO
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DC	David Campbell, GRI	GES	George Schatz, MO
GD	Gerrit Davidse, MO	DT	Dan Tenaglio, http://www.missouriplants.com/
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BH	Barry Hammel, MO	CU	Carmen Ulloa, MO
		HW	High Wilson, TAMU
		GY	George Yatskievych, MO
		KY	Kay Yatskievych, MO

Research: Asteraceae (Compositae)

One of the earliest recognized flowering plant families on the planet, the Sunflower family—Asteraceae—is also one of the largest, rivaled only by the Orchid family, and representing nearly 10% of all known flowering plant species. Garden-variety members of the family include: asters, sunflowers, daisies, chrysanthemums, and cone flowers. Asteraceae exist on every continent except Antarctica, but with greatest concentrations occurring in Mexico, the United States, and Russia. The family's success is attributed to efficient pollination and strong chemical defenses, such as those found in *Tanacetum cinerariifolium*, which contains pyrethrin, a chemical used in many garden products as a natural insecticide.

The flowers of the Sunflower family are more rightly called "flowerheads," as they may contain up to hundreds of actual flowers. This aggregate or "composite" structure led to the family's traditional name Compositae. Most Asteraceae flowers are yellow, but other colors do exist, such as the unusual blue of chicory and the reds and purples of such primitive species as thistles. Despite the family's large size, surprisingly few species are economically important. Among them: artichokes, chamomile (tea), chicory (an additive to coffee), chrysanthemums (flowers), daisies (flowers, pyrethrin products), lettuces, and sunflowers (seeds, oil, and flowers); and in herbal medicine, arnica and echinacea.

Helianthus annus

GENUS: Helianthus annus / **COMMON NAME:** Sunflower / **HABIT:** Annual / **FAMILY:** Asteraceae
NATIVE RANGE: North America / **HEIGHT:** 3 to 10 feet **SPREAD:** 1.5 to 3 feet

Sunflowers (*Helianthus*) are a genus of about 70–80 species of annuals and perennials in the Asteraceae family. They should be grown in well-drained, neutral-to-alkaline soil in full sun. Photo by Tom Gulya.

MISSOURI BOTANICAL GARDEN

